**T05D01 – Heat Change Introduction**

Name \_\_\_\_\_\_\_\_\_KEY\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Problems: **Show ALL work for these problems**. Show a data table, the formula you are using, substituting into the formula, with UNITS and then the answer.

*No work = grade of 0.*

1. Calculate how much energy it takes to raise the temperature of 125 grams of aluminum from 100 to 245 degrees C. The specific heat of aluminum is 0.900 J/g degree C

q = ? q = mcΔT

m = 125 g Al q = (125 g)(0.900 J/goc)(145oc)

c = 0.900 J/goc q = 16,312.5 J

ΔT = +145 oc **q = 16.3 kJ (endothermic)**

2. Calculate the heat change needed to raise the temperature of 1000. g of water from 5.0 degrees C to 95.0 degrees C.

q = ? q = mcΔT

m = 1000 g H2O q = (1000 g)(4.184 J/goc)(90.0oc)

c = 4.184 J/goc q = + 376,560 J

ΔT = +90.0 oc **q = + 377 kJ (endothermic)**

3. Determine the specific heat of copper if it takes 10 500 J of energy to raise 520.0 grams of it from 27.0 degrees C to 245.0 degrees C.

q = + 10,500 J q = mcΔT

m = 520. g Cu 10500 J = (520 g)( s )(218oc)

c = \_\_\_\_\_\_\_ J/goc **c = 0.0926 J/goc**

ΔT = + 218 oc

4. Determine the specific heat of an unknown element if it takes 540 J to raise the temperature of 55.6 grams of this element from 5.0 to 95.0 degrees C.

q = + 540 J q = msΔT

m = 55.6. g Cu 540 J = (55.6 g)( s )(90oc)

s = \_\_\_\_\_\_\_ J/goc s = 0.1079 J/goc

ΔT = + 90.0oc

5. If a reaction (chemical or physical) takes in heat energy we say it is ……endothermic……….., and the sign of q is …( + )….

If a reaction gives (chemical or physical) gives off heat energy we say it is …exothermic……., and the sign of q is …( - )…..

**The first law of Thermodynamics says that the “energy of the universe is CONSTANT”**

**Therefore q = - q**

Using that concept solve each of the following problems:

1. 200. grams of water at 40. oC is mixed with an unknown amount of water at 0 oC. The final temperature of the mixture is 16 oC. Calculate the unknown quantity of water.

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| **H2OA** |  | **H2OB** |
| m = 200. g  c = 4.184 J/goc  Tf = 16oc  Ti = 40oc  ΔT = -24oc | qH2OA = - (qH2OB)  (mcΔT)H2OA = - (mcΔT)H2OB  (200**g**)(4.184 ~~J/g~~~~o~~~~c~~)(-24~~o~~~~c~~) = - (**gH2OB**)(4.184 ~~J~~/~~g~~~~o~~~~c~~)(16~~o~~~~c~~)  **mH2OB = 300 g** | m = \_\_\_\_ g  c = 4.184 J/goc  Tf = 16oc  Ti = 0oc  ΔT = 16oc |

1. Calculate the final temperature of the mixture when 150 grams of water at 28.9 oC is added to 445 grams of water at 75.5 oC.

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| **H2OA** |  | **H2OB** |
| m = 150 g  c = 4.184 J/goc  Tf = \_\_\_\_oc  Ti = 28.9oc  ΔT = Tf – 28.9oc | qH2OA = - (qH2OB)  (mcΔT)H2OA = - (mcΔT)H2OB  (150**g**)(~~4.184 J/g~~~~o~~~~c~~)( **Tfoc** – 28.9oc) = - (445g)(~~4.184 J/g~~~~o~~~~c~~)( **Tfoc** – 75.5oc)  (150**g**)( **Tfoc** – 28.9oc) = - (445g)( **Tfoc** – 75.5oc)  (150**Tfoc** – 4335)~~g~~~~o~~~~c~~ = ( -445**Tfoc** + 33597.5)~~g~~~~o~~~~c~~  595Tfoc = 37932.5  **Tf = 63.7oc** |  |

1. Calculate the initial temperature of a 55.5 grams piece of nickel that when placed into 100. grams of water at an initial temperature of 22.5 oC results in a mixture temperature of 27.4 oC [Specific Heat of Ni = 0.440 J/goc)

|  |  |  |  |
| --- | --- | --- | --- |
| **Ni** |  | **H2OB** | |
| m = 55.5 g  c = 0.440 J/goc  Tf = 27.4oc  Ti = \_\_\_\_oc  ΔT = 27.4oc – 28.9oc | qNi = - (qH2OB)  (mcΔT)Ni = - (mcΔT)H2OB  (55.5~~g~~)(0.440 J/~~g~~oc)(27.4oc-**Ti Ni**) = - (100~~.g~~)(4.184 J/~~g~~~~o~~~~c~~)( 4.9~~o~~~~c~~)  (24.4~~J~~/oc)(27.4oc-**Ti Ni**) = -2050 ~~J~~  (27.4oc-**Ti Ni**) = -84.0 oc  **Ti Ni = 111oc** | | m = 100. g  c = 4.184 J/goc  Tf = 27.4oc  Ti = 22.5oc  ΔT = 4.9oc |

1. When 1.34 grams of potassium bromide (KBr) dissolves in 74.0 grams of water in a coffee-cup calorimeter, the temperature drops from 291.0 K to 290.3 K. Assume all heat absorbed in the solution process comes from the water.
   1. Write a balanced equation for the solution process.

KBr (s) + H2O (l) 🡪 K+ (aq) + Br- (aq) + H2O OR **KBr (s) 🡪 K+ (aq) + Br- (aq)**

* 1. What is q of the water? Cannot find q of KBr directly so must find it for H2O and use q = -q for part (c).

qH2O = mcΔT qH2O = (74.0 ~~g~~)( 4.184 J/~~g~~~~o~~~~c~~)( - 0.7~~o~~~~c~~) = - 216 J

mH2O = 74.0 g

cH2O = 4.184 J/goc

ΔTH2O = 290.3-291.0 = - 0.7 K = - 0.7oc

* 1. What is q when potassium bromide dissolves?

qBr = -(qH2O)

qBr = -(-216J)

qBr = +216J

* 1. Is the process endothermic or exothermic? Explain.

q for the salt is positive (+) and therefore energy is taken in from the surroundings (water) making the heat change for KBr endothermic

* 1. What is the molar heat of solution if 1.34 grams of KBr were dissolved?

n (KBr) =

qmol = ΔH

* 1. Draw an energy diagram for this reaction

K+ (aq) + Br- (aq)

KBr (s)

Enthalpy

ΔH =

Enthalpy

* 1. Level 5: Calculate the energy change (∆H) when 10.00 moles of potassium bromide dissolves in

sufficient water.

= ΔH = 192 kJ

* 1. Level 6: Calculate the energy change (∆H) when 10.00 grams of potassium bromide dissolves in

sufficient water.

= ΔH = 1.61 kJ